Paleontological Research, vol. 4, no. 2, pp. 131–137, June 30, 2000

A new potamolepid freshwater sponge (Demospongiae) from the Miocene Nakamura Formation, central Japan

KEIJI MATSUOKA[1] and YOSHIKI MASUDA[2]

[1]*Toyohashi Museum of Natural History, 1–238, Oiwa-cho, Toyohashi, Aichi 441–3147, Japan (matsuoka@amitaj.or.jp)*

[2]*Department of Biology, Kawasaki Medical School, 577, Matsushima, Kurashiki, Okayama 701–0192, Japan*

Received 22 November 1998; Revised manuscript accepted 8 March 2000

Abstract. The freshwater sponge *Oncosclera kaniensis* sp. nov. of the demospongian family Potamolepidae is described from the Early Miocene Nakamura Formation (Mizunami Group) in Gifu Prefecture, central Japan. This is the first fossil record of the Potamolepidae in the world and also is the first documentation of fossil sponges from the Nakamura Formation. Paleoecology of *Oncosclera kaniensis* sp. nov. is briefly discussed.

Key words: freshwater sponge, Potamolepidae, *Oncosclera*, Early Miocene, Nakamura Formation

Introduction

A number of well preserved sponges assignable to a new species of the genus *Oncosclera* Volkmer-Ribeiro, 1970 of the family Potamolepidae (Demospongiae) were recovered from the Early Miocene Nakamura Formation, Mizunami Group in Gifu Prefecture, central Japan. This is the first fossil record of the genus *Oncosclera* as well as of the family Potamolepidae. The discovery dramatically extends the fossil record of the family Potamolepidae back to the Early Miocene. Recent species of potamolepid sponges are distributed in South America, Africa, and Asia, and have been considered as Gondwanian elements (Volkmer-Ribeiro and De Rosa-Barbosa, 1978). The discovery of a fossil potamolepid sponge from Japan is very important for future paleogeography and phylogenetic analysis. The purpose of this paper is to describe a new species and discuss its paleoecology.

Geologic setting

The fossil sponges were collected from tuffaceous sandstone exposed on a riverbed of the Kiso River, Dota area of the Minokamo basin, Kani City, Gifu Prefecture, central Japan (Figure 1). Distributed in this riverbed is the Mizunami Group, a stratotype of the Lower to Middle Miocene in Japan, that is composed of nonmarine sediments, while the group is composed of marine sediments in the neighboring Mizunami and Iwamura basins.

A recent detailed lithostratigraphical study of the Mizunami Group along the Kiso River in the Minokamo basin by Shikano (1995) has shown that the group can be divided into three formations in ascending orders: the Hachiya Formation, Nakamura Formation, and Hiramaki Formation. The Nakamura Formation, from which the fossil sponges were recovered, is 130 m thick, of fluvial and lacustrine origin, and subdivided into the Lower Member, Middle Member, and Upper Member. The potamolepid sponges described here were recovered from a sandstone layer of the Upper Member, about 2 m below the contact with the Hiramaki Formation (Figure 2). The Upper Member is estimated to be 30 m thick and consists of tuffaceous mudstone, sandstone, conglomerate, and lignite. The basal layer of the Upper Member consists of massive tuff, and was dated as 21.7± 1.5 Ma by the fission track method (Shikano, 1995).

The sponge-bearing sandstone layer is ill-sorted and contains much granular material and organic debris. Other fossils associated in this sandstone layer are diatoms, macroplants, molluscs, fishes, and mammals. The fossil molluscs in this sandstone include an undescribed viviparid gastropod, *Bellamya* sp. and undetermined unionid bivalves such as *Anodonta* sp. and "*Unio*" sp. The fossil fishes were identified as *Cypris* sp., Cyprininae gen. et sp. indet., and Cultrinae gen. et sp. indet. (Yasuno, 1982; 1983). The fossil molluscs and cyprinids are all permanent freshwater dwellers. The fossil mammals from the sandstone layer are *Plesiosorex* sp., *Amphilagus* sp., *Youngofiber sinensis*, *Anchitheriomys* sp., *Pseudotheridomys* sp., and *Apeomys* (?) sp. (Tomida and Setoguchi, 1994; Tomida and Goda, 1995; Tomida *et al.*, 1995).

Systematic description

Class Demospongiae Sollas, 1885
Order Hadromerida Topsent, 1894
Family Potamolepidae Brien, 1967
Genus ***Oncosclera*** Volkmer-Ribeiro, 1970

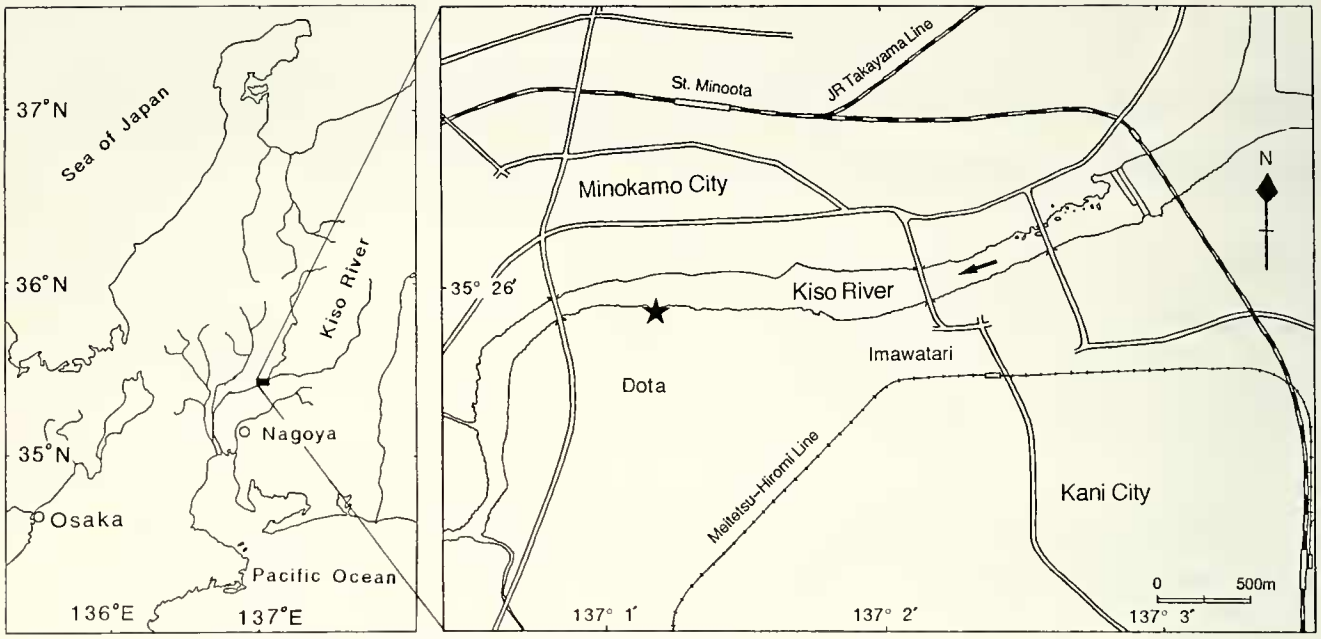

Figure 1. Map showing the sponge locality of the Nakamura Formation, Dota, Kani City.

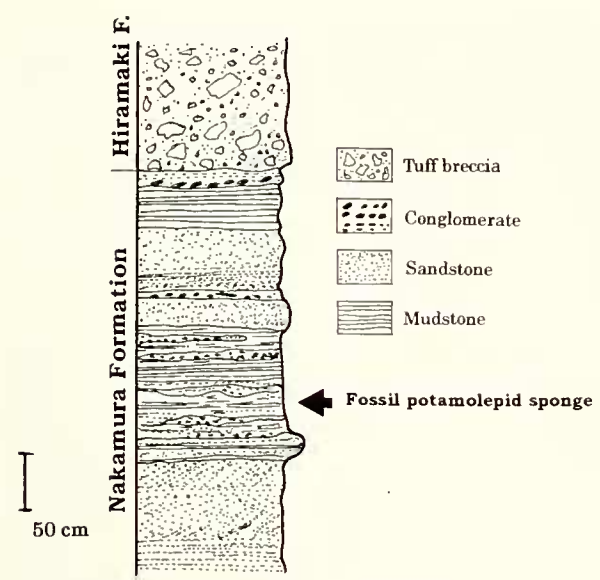

Figure 2. Columnar section showing the sponge-bearing horizon in the Nakamura Formation.

Type species: *Spongilla jewelli* Volkmer, by original designation.

Diagnosis.—Megascleres slightly curved, stout, occasionally microspined, amphioxea to amphistrongyla. Microscleres absent. Gemmoscleres short, stout, feebly curved, extremely variable, amphistrongyla or amphioxea, swollen at central portion, usually spined; spines more numerous at both ends.

Discussion.—Brien (1967) proposed the new family Potamolepidae for the Ethiopian genera *Potamolepis* and *Potamophloios*. The family consists of six genera: *Oncosclera*, *Uruguaya*, *Sterrastrolepis*, *Potamolepis*, *Potamophloios*, and *Stratospongilla*, and the family is considered to have been derived from a certain marine group of the order Hadromerida (Volkmer-Ribeiro and De Rosa-Barbosa, 1978). Of the six genera above, *Oncosclera*, *Uruguaya* and *Sterrastrolepis* from South America have been thought in part to be relicts of the Gondwanian fauna (Volkmer-Ribeiro, 1981).

Oncosclera was originally introduced as a genus of the family Spongillidae by Volkmer-Ribeiro (1970), which included two living species in Brazil, *O. jewelli* (Volkmer, 1963) and *O. navicella* (Carter, 1881). This genus is very close to the genus *Stratospongilla*, but differs from the latter in the absence of microscleres. The genus *Oncosclera* from South America consists of ten species: *Oncosclera petricola* (Bonetto and Ezcurra, 1967), *O. stolonifera* (Bonetto and Ezcurra, 1967), *O. schubarti* (Bonetto and Ezcurra, 1967), *O. ponsi* (Bonetto and Ezcurra, 1968), *O. tonollii* (Bonetto and Ezcurra, 1968), *O. atrata* (Bonetto and Ezcurra, 1970), *O. spinifera* (Bonetto and Ezcurra, 1973), and *O. intermedia* (Bonetto and Ezcurra, 1973) by Volkmer-Ribeiro (1981), who suggested that the number will be reduced by synonymies in future studies. *Spongilla* (*Stratospongilla*) *diahoti* Rützler, 1968 from northern New Caledonia was transferred to the genus *Oncosclera* by Volkmer-Ribeiro and Rützler (1997). According to Volkmer-Ribeiro (1970, 1981), *Spongilla rousseletti* Kirkpatrick, 1906 and *S.*(*Stratospongilla*) *shulbotzi* Weltner, 1913 from central Africa, *S.* (*Stratospongilla*) *gilsoni* Topsent, 1912 from the Fiji Islands, and *S. clementis* Annandale, 1909 from the Philippines belong to the genus *Oncosclera*.

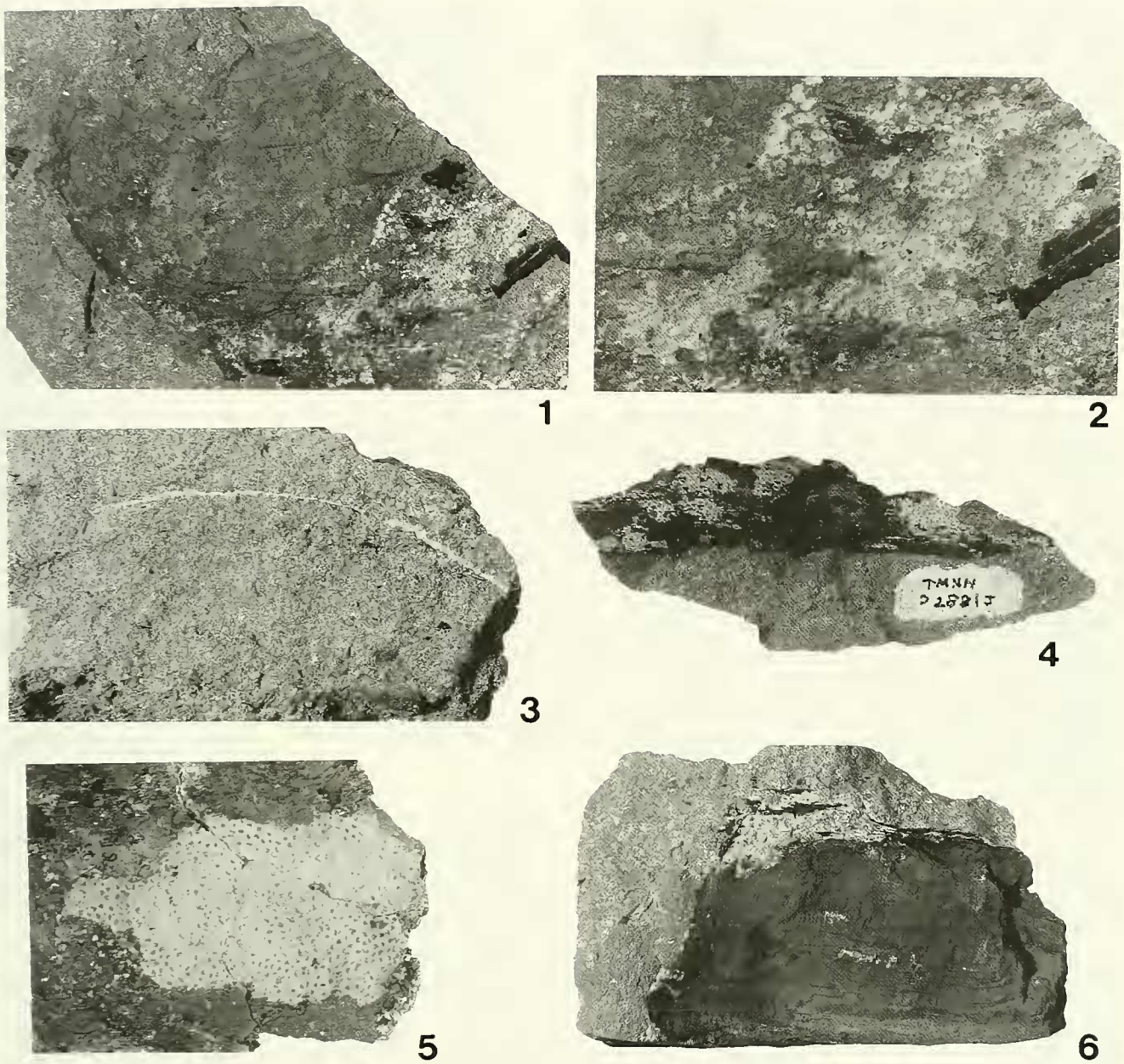

Figure 3. *Oncosclera kaniensis* sp. nov. **1**. Sponge bodies encrust the postero-ventral area of the left valve of *Anodonta* sp., TMNH-02882 (paratype), ×1. **2**. Enlargement of the sponge bodies of TMNH-02882, ×2.1. **3**. Sponge bodies encrust the surface of *Anodonta* sp., vertical section, TMNH-02889a (paratype), ×1.2. **4**. Sponge bodies encrust the surface of a cortex fragment (black color), TMNH-02881j (holotype), ×1.2. **5**. Attached surface of sponge bodies, TMNH-02886 (paratype), showing the outline of the gemmules represented by ring spots, ×2.0. **6**. Sponge bodies encrust the surface of a wood fragment, TMNH-02887, ×1.2.

Oncosclera kaniensis sp. nov.

Figures 3–5

Type locality.—Riverbed on the Kiso River, Dota, Kani City, Gifu Prefecture, Japan (Figure 1).

Etymology.—The species name is after Kani City, the municipality of the type locality.

Material studied.—Twenty-two specimens. Holotype: TMNH-02881 a–m, on 13 isolated blocks. Paratypes: TMNH-02885, 2883a, b, 02882, 02884 a, b, 02886. All deposited in the Toyohashi Museum of Natural History.

Diagnosis.—A species of *Oncosclera* characterized by

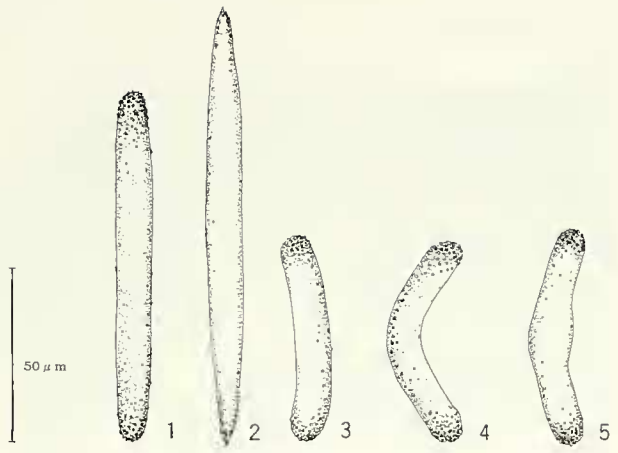

Figure 4. Spicular components of *Oncosclera kaniensis* sp. nov. **1**. Amphistrongylous megasclere. **2**. Amphioxeous megasclere. **3**–**5**. Three forms of gemmoscleres. Scale bar= 50μm.

domination of amphistrongylous megascleres, small amount of amphioxeous megascleres, amphistrongylous gemmoscleres, and dense covering of spines at both ends.

Description.—Sponge encrusting shell surfaces of bivalve and wood fragments. Sponge surface even and generally less than 1 mm in thickness. Skeletal components consisting of megascleres and gemmoscleres. Gemmules with round spots, firmly adhering to basal part of sponge body, about 500 μm in diameter, but compressed subspherically. Megascleres moderately small, almost straight, solid, amphistrongyla to amphioxea, covered with distinct spines at both ends, 100 to 179 μm in length and 7 to 15 μm in thickness. Majority of megascleres stout and cylindrical amphistrongyla (Figure 4.1), occasionally with a few intermixed true amphioxea (Figure 4.2). Microscleres absent. Gemmoscleres stout, variably curved, inflated at middle (Figure 4.3–4.5); amphistrongyla densely covered with distinct spines that are numerous at both ends; some of spines polyfurcate, and inner curved area smooth, 23 to 100 μm in length, 4 to 7 μm in thickness.

Comparison.—The present new species is assigned to the genus *Oncosclera* in its shape and surface ornamentation of megasclere and gemmosclere. The new species is similar to the following Recent species from Argentina: *Oncosclera ponsi* (Bonetto and Ezcurra, 1968), *Oncosclera atrata* (Bonetto and Ezcurra, 1970), and *Oncosclera tonollii* (Bonetto and Ezcurra, 1968). Of the three species *O. kaniensis* sp. nov. is most similar to *Oncosclera ponsi* in spicular components, but it differs in having spinose amphioxeous megascleres. The present new species differs from *Oncosclera atrata* from the Parana River, Argentina in having amphistrongyla densely covered with distinct spines at both ends of the gemmoscleres. It also differs from *Oncosclera tonollii* from the Uruguay River, Argentina (Bonetto and Ezcurra, 1967) in having a less spinose surface of gemmoscleres and megascleres. This new species has gemmoscleres similar to the Recent species *Oncosclera jewelli* (Volkmer, 1963) known only from the Tainhas River of Brazil (Volkmer-Ribeiro, 1970) and *O. schubarti* (Bonetto and Ezcurra, 1967) from the Uruguay River, Argentina, but differs distinctly from the latter species in its spinose amphistrongylous and amphioxeous megascleres.

Paleoecology.—Potamolepids commonly have highly silicified skeletons and lack spongin fibers. Many species of the genus *Oncosclera* encrust stable bottom surfaces in streams. *Oncosclera atrata* inhabits a curved bank of a tributary of the Parana River in the Misiones Province, Argentina, where it encrusts surfaces of partly submerged rocks (Bonetto and Ezcurra, 1970). *Oncosclera ponsi* and *O. tonollii* encrust rocky bottoms in rapid and turbulent waters in the Uruguay River (Bonetto and Ezcurra, 1968). Both species grow in the upper and lower surfaces of the rocks, and the sponges encrusting the lower surfaces are disposed to grow exuberantly. *Oncosclera jewelli* in the Tainhas River of Brazil also encrusts exclusively stable bottom surfaces in fast streams close to rapids and/or falls. *Oncosclera navicella* in the Amazon River of Brazil and Iguazu Fall of Argentina, on the other hand, encrusts ligaments and valves of the living freshwater bivalve *Anodontites trapesialis forbesianus* and *Paxyodon syrmatophorus* (Volkmer-Ribeiro, 1970; Tavares and Volkmer-Ribeiro, 1997).

Oncosclera kaniensis sp. nov. is represented entirely by fossilized sponge bodies and encrusts two types of substrates: shell surface of the unionid bivalve *Anodonta* sp.(Figure 3.1–3.3) and surface of wood fragments (Figure 3.4–3.6). The sponge bodies on the unionid bivalve encrust the ventral and posterior parts of almost horizontally embedded articulated valves that are preserved as composite moulds (Figure 6.1). They also encrust the outer surfaces of isolated valves that are diagenetically compacted and embedded with the convex side up (Figure 6.2). The sponge bodies also encrust strongly compacted woods almost entirely (Figure 6.3) and encrust partly the wood fragments that remain in possession of annual rings (Figure 6.4). The shells and wood fragments may have provided hard substrates for colonization of the fossil sponges in the soft bottom environment. The gemmules of *O. kaniensis* sp. nov. can be seen by naked eye as ring spots. The gemmules of the fossils are located at the basal portion of the sponge as in *O. jewelli* and *O. navicella* (Figure 3.5). These facts strongly suggest that *O. kaniensis* sp. nov. dwelled in a river like the Recent *Oncosclera* species and had a habitat preference to the upper and lower surfaces of hard substrates (Figure 6.5 – 6.8). The unusual preservation of the megascleres and gemmoscleres of *O. kaniensis* sp. nov. may have resulted from its comparatively stout skeleton, strong attachment to the substrates and rapid burial after death.

Acknowledgments

We thank C. Volkmer-Ribeiro of Museu Rio-Grandense de Ciencias Natures, Porto Allegre, Brazil and Junji Itoigawa of Sugiyama Jogakuen University, Nagoya for reading the manuscript and offering valuable suggestions. Appreciation is also expressed to T. Goda, Aichi Prefecture, Japan for supplying specimens of the fossil sponges for this study.

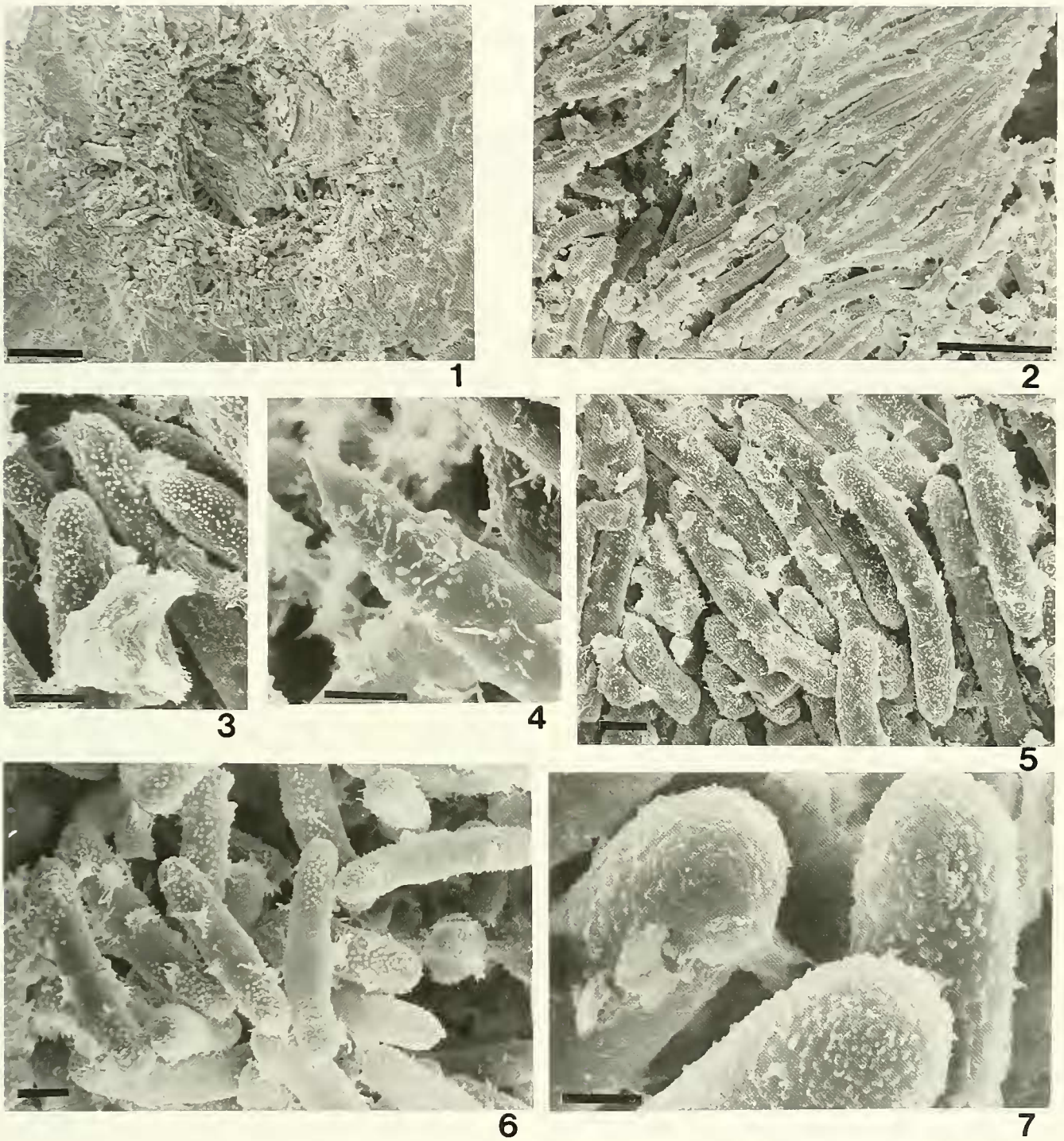

Figure 5. SEM micrographs of *Oncosclera kaniensis* sp. nov. **1**. Gemmule, vertical section, scale bar=100 μm. **2**. Amphistrongylous megascleres, scale bar=50 μm. **3**. End parts of amphistrongylous megascleres, scale bar=10 μm. **4**. End parts of amphioxeous megascleres, scale bar=5 μm. **5**. Gemmoscleres, scale bar=10 μm. **6**. Gemmoscleres, scale bar=10 μm. **7**. End parts of gemmoscleres. scale bar=5 μm.

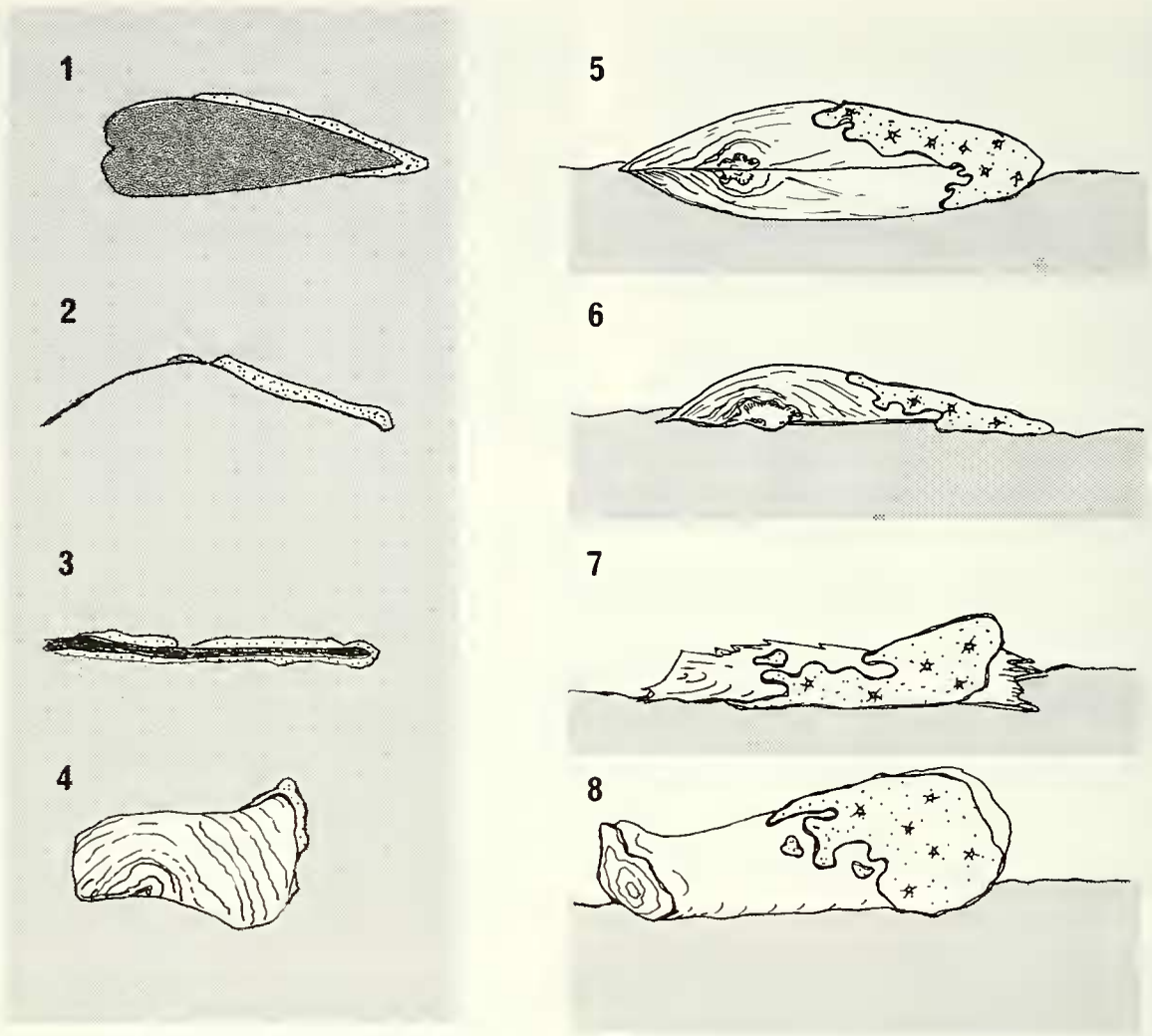

Figure 6. Mode of occurrences of *Oncosclera kaniensis* sp. nov. **1–4.** Four types of encrustation. **1.** Sponge bodies encrust an articulated valve of the unionid bivalve *Anodonta* sp. The bivalve is embedded with its comissure plane almost horizontal and is preserved as a composite mould. **2.** Sponge bodies encrust the outer surface of an isolated valve of the unionid bivalve *Anodonta* sp. The valve is compacted diagenetically. **3.** Sponge bodies encrust a strongly compacted wood fragment almost entirely. **4.** Sponge bodies encrust a wood fragment that retains its annual rings. **5–8.** Reconstruction of the four types of encrustation for 1 to 4, respectively.

References

Annandale, N., 1909: Freshwater sponges in the collection of the United States National Museum. —Part 1. Specimens from the Philippines and Australia. *Proceedings of the United States National Museum*, vol. 36, p. 627–623.

Bonetto, A. A. and Ezcurra, I. D., 1967: Esponjas del Noreste Argentino. *Acta Zoologica Lilloana*, vol. 23, p. 331–347.

Bonetto, A. A. and Ezcurra, I. D., 1968: El genero *Spongilla* Lamarck en el Río Uruguay (Porifera, Spongillidae). *Physis*, vol. 27, no. 75, p. 429–436.

Bonetto, A. A. and Ezcurra, I. D., 1970: Esponjas de los afluentes del alto Parana en la provincia de Misiones. *Acta Zoologica Lilloana*, vol. 27, p. 37–61.

Bonetto, A. A. and Ezcurra, I. D., 1973: Aportes al conocimiento de las esponjas del Orinoco. *Physis*, vol. 32, no. 84, p. 13–18.

Brien, P., 1967: Formation des statoblastes dans le genre *Potamolepis*: *P. symoensi* (Marshall), *P. pechuelli* (Marshall), *P. schoutedeni* (Burton). *Bulletin de la Classe des Sciences, Académie royale de Belgique*, vol. 53, p. 573–590.

Carter, H. J., 1881: History and classification of the known species of *Spongilla*. *The Annals and Magazine of Natural History, 5th Series*, vol. 7, p. 77–107, pls. 5 6.

Kirkpatrick, R., 1906: Report on the Porifera, with notes on species from the Nile and Zambesi. Zoological results of the third Tanganyika Expedition. *Proceedings of the*

Zoological Society of London, vol. 2, no. 1, p. 218–227.

Rützler, K., 1968: Freshwater sponges from New Caledonia. *Cahiers O. R. S. T. O. M. (Office de la Recherche Scientifique et Technique Outre-Mer), Série Hydrobiologie*, vol. 2, no. 1, p. 57–66.

Shikano, K., 1995: Stratigraphy of the Nakamura Formation. *In*, Paleontology and stratigraphy of the Nakamura Formation in Minokamo Basin. *Board of Education of Minokamo City*, p. 2–18. (*in Japanese*)

Tavares, Maria da Conceição Marques and Volkmer-Ribeiro, C., 1997: Redescrição das esponjas de água doce *Oncosclera navicella* (Carter, 1881) (Potamolepidae) e *Spongilla spoliata* Volkmer-Ribeiro & Maciel, 1983 (Spongillidae). *Biociências, Porto Alegre*, vol. 5, no. 1, p. 97–111.

Tomida, Y. and Goda, T., 1995: Dota local fauna: the first small mammal fauna from the Japanese Tertiary. *Journal of Vertebrate Paleontology*, vol. 15, no. 3 suppl., 57A.

Tomida, Y., Kawai, K., Setoguchi, T. and Ozawa, T., 1995: A new record of *Youngofiber* (Castoridae: Mammalia) from the Early Miocene of Kani City, Central Japan. *Bulletin of the National Science Museum, Ser. C,* vol. 21, nos. 3, 4, p.103–109.

Tomida, Y. and Setoguchi, T., 1994: Tertiary rodents from Japan. *National Science Museum Monographs*, no. 8, p. 185–195.

Topsent, E., 1912: Description de *Spongilla* (*Stratospongilla*) *gilsoni* n. sp. *Annales de Biologie Lacustre*, vol. 5, p. 187–190.

Volkmer, C., 1963: *Spongilla jewelli* n. sp. from fresh-water sponge at Brazil. *Anais Academia Brasileira de Ciencia*, vol. 35, no. 2, p. 271–273.

Volkmer-Ribeiro, C., 1970: *Oncosclera* — a new genus of freshwater sponges (Porifera-Spongillidae) with redescription of two species. *Amazoniana*, vol. 2, no. 4, p. 435–442.

Volkmer-Ribeiro, C., 1981: Porifera. *In*, Huribert, S. H., Rodriguez, G., and Santos, N. D. *eds.*, *Aquatic Biota of Tropical South America, Part 2: Anarthropoda*. San Diego State University, San Diego, California. 298 pp.

Volkmer-Ribeiro, C. and De Rosa-Barbosa, R., 1978: Neotropical freshwater sponges of the family Potamolepidae Brien, 1967, p. 503–511. *In*, Levi, C. and Boury-Esnault, N. *eds.*, *Biologie des Spongiaires*, Colloques Internationaux Centre National de la Recherche Scientifique (Paris), no. 291.

Volkmer-Ribeiro, C. and Rützler, K., 1997: *Pachyrotula*, a new genus of freshwater sponges from New Caledonia (Porifera: Spongillidae). *Proceedings of the Biological Society of Washington*, vol. 110, no. 4, p. 489–501.

Weltner, W., 1913: Süsswasserschwämme (Spongillidae) der Deutschen Zentralafrika-Expedition 1907 - 1908. *In*, *Wissenschaftliche Ergebnisse der Deutschen Zentral-Afrika-Expedition, 1907–1908*, vol. 4, (*Zoology*) 12, p. 475–485.

Yasuno, T., 1983: Fossil pharyngeal teeth of sub-family Cultrinae collected from the Miocene Kani Group and Plio-Pleistocene Kobiwako Group in Japan. *Journal of Fossil Research*, vol. 16, p. 41–46. (*in Japanese with English abstract*)